Collaboration and Synergy among Government, Industry and Academia in M&S Domain: Turkey's Approach

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ABSTRACT

Modeling and Simulation Technologies have been used in both military and civil areas for a long time in Turkey. In the last decade, relevant parties in this area have started to follow a more systemic approach in order to utilize and advance the state of the art modeling and simulation technologies. In this new approach, government, industry and academia have been working in collaboration with each other. In this paper, Turkey approach to exploit and advance modeling and simulation technologies will be presented with the future plans.

1.0 INTRODUCTION

Optimal utilization of M&S technologies are inevitable for the armed forces of modern world to overcome the new kinds of threats based on unconventional warfare. M&S technologies are crucial from tactical level to strategic level in many areas of an army such as training, analysis, doctrine development, concept development and exercise. Besides, embedding simulation components into weapon systems has started to emerge to support the forces on the battlefield. On the other hand, non-military use of M&S has also started covering a wide range of areas such as homeland security, transportation, environment, communication, energy, etc. Use of M&S in civil areas facilitate the solution of some complex problems.

As a country being aware of increasing importance of M&S, Turkey has been using modelling and simulation technologies effectively and extensively both in military and civil areas for the last couple of decades. Many governmental and non-governmental organizations make use of M&S not only for training their personnel and for designing complex systems but also for receiving decision support at higher level of management. Currently, there are over 300 training simulators being used in Turkish Armed Forces (TAF). On the other hand, civil organizations also have been using M&S Technologies at a certain level. This usage has been in various sectors such as finance, construction, transportation, environment, For instance, Turkish railways has been using train simulators since a few decades Turkish ministry of environment in collaboration with undersecratiat for maritime affairs mandated all sea ports to get ready to hazardous situations such as oil tanker accidents by carrying out risk and contingency plans based on M&S. All Turkish sea ports prepared these plans to the authorities by modelling their sea region and performing some simulation runs to take detailed measures and intervention in case of an accident or a natural disaster.

The extensive usage of M&S technologies in Turkey and the current procurement policies has triggered the industry to develop capabilities in this direction which is also facilitated by the Undersecretariat for Defence Industries (SSM), the major defence procurement authority of Turkey. Two of the strategic goals of the undersecretariat is to increase the portion of meeting the system requirements through local infrastructure to 50 percent and "cost +" procurement strategy for R&D projects. Additionally, R&D grants from several sources such as Turkish government or EU's Framework Programmes motivated the local industry to build capability and develop products also in M&S area.

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Modeling and Simulation Technologies have been used in both military and civil areas for a long time in Turkey. In the last decade, relevant parties in this area have started to follow a more systemic approach in order to utilize and advance the state of the art modeling and simulation technologies. In this new approach, government, industry and academia have been working in collaboration with each other. In this paper, Turkey approach to exploit and advance modeling and simulation technologies will be presented with the future plans.

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As the importance and thus the demand for M&S technologies started to increase in Turkey, Turkish Armed Forces and Undersecretariat for Defence Industries initiated various kinds of research collaborations with some prominent universities in Turkey eleven years ago. One of the results of this initiative is MODSİMMER which is an M&S R&D Center established at Middle East Technical University. More information about MODSIMMER is given in Section 3. .

Regulations put forward for R&D projects in Turkey necessitate collaboration among industry, academia and government. Therefore, industry is also involved in the R&D projects carried out by universities supported by TAF and SSM. Industry, government and academia collaborate not only in R&D projects, but also in MODSİM Platform in which national strategies, policies, standards, etc. in M&S area are discussed and the authorities at various levels are informed and trained about M&S technologies. MODSİM platform is elaborated in the following sections.

The organization of this paper is as follows: in the following section, the approach of TAF and SSM is given and the projects initiated are listed with brief descriptions. In Section 3.0, the role of academia, mainly MODSİMMER which is located at Middle East Technical University, is discussed. In the next section, we describe how to disseminate information and how to create awareness on M&S in Turkey. In Section 5.0, the role of local industry is given. In the final section, the paper is summarized.

2.0 A SYSTEMIC APPROACH TO M&S BY TURKISH ARMED FORCES AND THE UNDERSECRETARIAT FOR DEFENCE INDUSTRIES

TAF and SSM have a systemic approach to M&S since 1996 when preparation of an M&S Master Plan started and completed in 1998. The tasks in this master plan have been realized with a strong support of SSM. As seen in Figure 1, there are some projects defined at strategic, operational and tactical levels besides to infrastructure level. Some projects on interoperability of the M&S and C2 Systems have also been defined and planned in the master plan. Below, some of the R&D projects which are carried out by industry and academia jointly are briefly presented.

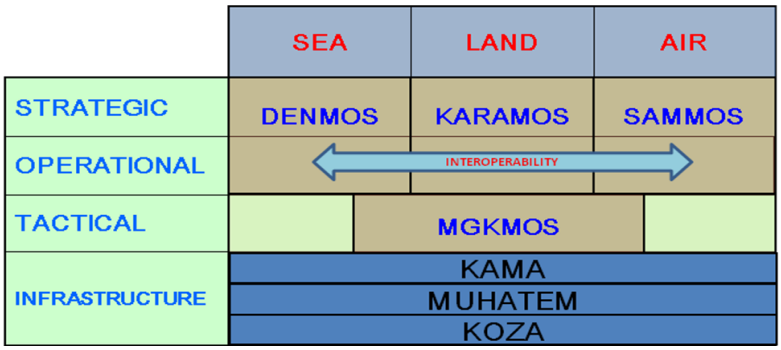

Figure 1: An Overview of M&S Projects in the Master Plan

SENSIM: SENSOR SIMULATION OPTIMIZATION

This is the first project started at MODSİMMER in 1999. The goal is to determine the optimal positioning and number of moving (land and air) and fixed sensor platforms by considering their types and some cost criteria. The optimization is based on a genetic algorithm. The project also involves synthetic environment creation and visualization of sensor coverage.

KAMMOS: MODELLING AND SIMULATION OF LAND-LAND BATTLES: This project started in 2000, ended in 2005 and was performed in two stages [1]. The goal is to model tactical level land combat from the allied forces' viewpoint using a semi-dynamic method which decomposes the battle between heterogeneous forces into stages and mini battles. The developed models are used in a decision support system that incorporates optimization of force allocations, prediction of whether stage targets are reached or not, update of weapon cost/effectiveness. The second stage of the project has the following additional features: scenario definition tool, more realistic modelling of weapon and ammunition planning intended for land-land battles, a novel planning methodology that includes the update of static weapon ammunition values and evaluation of control parameters.

SAVMOS: MODELING AND SIMULATION OF SMALL SCALED CONTINGENCY OPERATION: The first phase of this project carried out at MODSİMMER between 2002 and 2004 [2,4]. Next, Havelsan converted the resultant prototype into a commercial product. The functions of the product which is being used can be listed as:

- Analysis of the efficiency of the resources, such as weapons, personnel, ammution etc.
- Enhancement of the instantaneous decision making capability of leaders by providing trainings of small-scale "attack/defense operation", "trail operation", "internal security operation", "post defense" and "special forces operations" on digital environment
- Reconnaissance by using terrain database of synthetic environment that has an ability of 2D and 3D visualization

The commercialized product is now being used by TAF to enhance the planning capability of leaders for small scale operations .

Figure 2: A Screen Shot from BASKIN System

The system includes the following features:

- Scenario Preparation
- Simulation Management and Control
- Agent Management and Control
- 2 and 3 Dimensional Synthetic Environment Visualization
- Simulation Data Logging
- Report Generation and Data Export Capability
- Replay and Analysis Tool

SAMMOS: LAND BASED ACTIVE AIR DEFENCE SIMULATION SYSTEM: The purpose of this project is to develop a simulation system to analyze Land based Air Defense systems at strategic and operative level. The aim is to build a simulation model library, a mission library and a set of software tools, which are simulation execution tool, scenario preparation tool, model development tool, analysis & report tool and system management tool. Libraries and the software allow analysts to generate air defense scenarios to measure and analyze the command control strategies and architecture, utility of military systems, defense achievement of weapon systems and deployment strategy of the forces. The project has also some technical concerns such as having an interoperable, reusable and extendable constructive simulation environment.

KAMA: A TOOL SET FOR C4ISRMOS CONCEPTUAL MODEL DEVELOPMENT: This project is developed between 2005-2007 [3]. Since modeling and simulation projects include challenges such as interoperability and integration of domain knowledge from various sources, a conceptual modelling toolset is developed for modelling C4ISR mission space in a convenient, effective and efficient manner. The toolset also allows multi user collaboration and reusability to define conceptual models at several levels of detail. Conceptual models of all M&S projects are to be defined and stored centrally in a warehouse using this toolset, named as KAMA.

JTFSIM: JOINT TASK FORCE MODELLING and SIMULATION: JTFSIM is used to analyze and evaluate the complicated combat environments defined by tactics, scenarios, weapon systems, perception systems. The resultant tool will enable the followings: military operation planning, simulation based acquisition, effectiveness analysis of weapon and sensor systems, force structure, and analysis and decision support by means of these features:

- scenario generation and planning support tools for preparing simulation models, synthetic environment, force structure, combat plan
- Simulation Management and Control
- 2 and 3 Dimensional Synthetic Environment Visualization
- Simulation Data Logging
- Report Generation and Data Export Capability
- Replay

The tool is based on constructive and distributed simulation compliant with HLA 1516. The main scenario involves a brigade attacking a battalion where units at the team level and a single autonomous soldier carrying an anti-tank missile.

DEHOS: A NAVAL WAR GAME SIMULATION SYSTEM: This system has been developed for Turkish Naval Forces Command by Meteksan Savunma since 2007. The aims are to evaluate and enhance mission execution effectiveness of Turkish Navy in the sea area of its interest and its influence with all combatant elements, to experiment and evaluate existing operational plans. Additionally, to evaluate and experiment effect of possible systems and platforms to the

existing forces and to provide a simulation environment to enable vision to form and use forces. Main Categories of DEHOS Models are listed as:

- Platforms (surface, submarine etc...)
- Sensors (Radar, Sonar, IR etc...)
- Weapons (Guided Missile/Missile, Naval Mine /Torpedo Mine/Ascending Mine, etc…)
- Counter Measure (IR Decoy, Acoustic Decoy, Chaff etc…)
- Communication (RF Communication devices etc…)
- DEHOS, with models listed above, supports:
- Surface to Air, Air to Surface, Surface to Surface, Surface to Ground engagements
- Attachment and Detachment between platforms
- Surveillance, ECM, ECCM
- Mine operations
- Amphibious operation
- Logistic Operations

2.0 ACADEMIA ROLE

The M&S initiative started by TAF and SSM also involve academic and research institutes besides industry. An R&D Center called MODSİMMER at Middle East Technical University (METU) takes place at a crucial position of this initiative. Additionally, METU collaborated with TAF to open a graduate program on M&S for military personnel. More information on MODSİMMER and graduate program is given in the following two subsections.

2.1 A Center of Excellence for Modeling and Simulation: METU-TAF MODSIMMER

Middle East Technical University - Turkish Armed Forces Modeling and Simulation Research and Development Center (METU-TAF MODSIMMER) is established to facilitate the development of an integrated Joint Operations Simulation System (JOSIMS) in line with 21st Century technologies and standards based on a collaboration agreement among Turkish Armed Forces (TAF), Undersecretariat for Defense Industries (SSM) and Middle East Technical University (METU).

The METU-TAF Modeling and Simulation (MODSIM) joint activity was first initiated in June 1999 as a Research and Development (R&D) laboratory. Later, in May 2001, it took the center status, known as METU-TAF MODSIMMER. Nowadays, the center is planning to expand its activities in order to become a Center of Excellence for Modeling and Simulation Technologies with the support of State Planning Organization (DPT). Missions of the center include the followings:

- To help conduct basic and applied research and development necessary to realize analytical and simulation systems required for the achievement of JOSIMS, in terms of prototypes and products.
- To facilitate the creation of technical infrastructure for JOSIMS, in terms of standards, procedures and technologies.
- To provide education and training to raise the level of awareness and expertise regarding Military MODSIM applications.

The center focuses on building national MODSIM capabilities, through raising the awareness and importance of development of defense related MODSIM technologies and the required infrastructure. The center has been involved in the development of high resolution virtual and constructive visual simulation systems as well as integrated advanced analytical models.

With the progress of basic and applied research work, the center facilitates the necessary academic support for the development of MODSIM based systems in order to contribute to the national defense industry. The cooperation between academia and industry is expected to contribute to the peace time operational defense capabilities, as well as industry and University's R&D achievements in MODSIM field.

By increasing the national R&D activities required for the MODSIM based systems in Turkey, it will be possible to consciously influence the future direction and amount of investment and procurement in this field.

In the light of the principles, rules, standards and priorities mentioned in TAF MODSIM Master Plan Document, the following activities are executed:

- Developing analytical models and simulation systems that are ready to use, credible, integrated with C4ISR systems.
- Creating synthetic environments and/or virtual prototypes of concepts and technologies related with information, material procurement and weapon systems that TAF (Turkish Armed Forces) plans to acquire, and analyzing these during research, development and engineering phases.
- Identifying and updating principles and standards related with development of national models and simulation systems.
- Coordinating MODSIM research activities within Middle East Technical University and nationwide.
- Serving as a MODSIM consultant to Turkish Armed Forces.
- Organizing scientific and technical meetings (seminars, conferences, workshops, etc.).

Academic activities are as follows:

- To conduct R&D to achieve the conceptual basis for the MODSIM technologies and create the necessary infrastructure.
- To create a research environment for the military personnel enrolled in the METU MODSIM Master of Science and other academic programs to contribute to the R&D in the defence related MODSIM applications.

The objectives of METU academic activities are:

- To help creating know-how and expertise needed by Turkish Armed Forces and the defence industry in the field of MODSIM
- To sponsor and develop interdisciplinary R&D in the field of MODSIM based defence applications
- To provide MODSIM education and training for the TAF personnel working in the field
- To construct a bridge between the national defence long/midterm MODSIM needs and educational and training needs of the industry in this field

METU Departments Involving in MODSİM Projects

- Aerospace Engineering
- Computer Education and Instructional Technology
- Computer Engineering
- Electrical and Electronics Engineering
- Industrial Design
- Industrial Engineering
- Mechanical Engineering
- Psychology
- Informatics Institute

2.2 MASTER OF SCIENCE IN MODELING AND SIMULATION

As a part of the mentioned systemic approach, Informatics Institute opened a Master of Science in Modeling and Simulation (MSc in MODSIM) in 1999. This is an interdisciplinary program focusing on operations research modeling, virtual environments, and computer simulation. The curriculum is designed to develop and integrate modeling and simulation skills with special emphasis on application of these skills in virtual environments. The objectives of the program are:

- to educate graduates from different disciplines in the theoretical and practical aspects of modeling, virtual environments, and computer simulation
- to support and encourage interdisciplinary research in this field
- to meet modeling and simulation education needs of defence industry and TAF

MODSIM Program has two tracks: Decision Models and Virtual Environments. Each track has background requirements, core courses, and elective courses as defined in the curricula. the list of courses that can be taken by a MODSİM MSc student are Deterministic Decision Models, System Simulation, Object-Oriented Programming, Distributed Simulation, Stochastic Decision Models, Mathematical Modeling and Applications, Computer Graphics, Software Engineering, Elective Courses Mathematical Models in Defense Analysis, Combinatorial Analysis, Scheduling Models, Decision Analysis, Decision Support System Design and Implementation, Simulation Output Analysis, Statistical Data Analysis, Virtual Reality, Artificial Intelligence, Human Computer Interfacing, Fundamentals of GIS, Physics-Based Modeling, Logistics Engineering and Management.

2.3 DISSEMINATION OF INFORMATION ON M&S

The most important arena for dissemination is biannual national m&S conferences, called as USMOS. It is the only conference in the defence modeling and simulation (MODSIM) area in Turkey which is organized by METU-TAF-MODSIMMER, with the support of Ministry of Defence, General Staff and Undersecretariat for Defence Industry; and with the cooperation of Defense Sciences Institute of Military Academy, Naval Science and Engineering Institute of Naval Academy, Aeronautics and Space Technologies Institute of Air Force Academy. The number of papers and their categories presented during USMOS 2005, USMOS 2007, USMOS 2009 is given in Figure 2.

The basic and applied researches on MODSIM that are performed by TAF, academia, civil and military and research agencies has created a proper environment in order to disseminate the results about the technology and the system development projects.

CATEGORIES OF PAPERS PRESENTED IN USMOS	2005	2007	2009
Agent Based Applications for Decision Support And Training	**7**	**8**	**6**
Interoperability and Infrastructure Issues Development	**8**	**20**	**10**
Optimisation and Analysis Models	**7**	**11**	**9**
Physiscs Based Models for M&S Applications	**4**	**8**	**11**
TOTAL	**26**	**47**	**36**

Figure 3: Categories of the Papers Presented in USMOS Conferences

In addition to USMOS conferences, workshops, seminars and meetings are organized mainly by MODSİMMER. Some of these are sponsored by MODSİM Platform. We also try to find opportunities to contribute to the M&S worldwide. For instance, this year, "The 2009 Summer Simulation Multiconference (SummerSim'09)" is hosted by MODSİMMER in İstanbul, Turkey. SummerSim'09 is an annual conference sponsored by The Society for Modeling and Simulation International.

3.0 LOCAL INDUSTRY IN THE AREA OF M&S

Local defence industry started building competitive capability on M&S in the last decade. There are some factors in increasing the competitive capability level of the industry. First of all, due to an excellent coordination and strategies carried out by SSM, local defence industry has developed a significant capability not only in M&S but also in other technological areas. Next, there have been many M&S projects initiated by TAF and SSM in recent years. Next, industry is in collaboration with academia while working on R&D projects as recommended and sometimes required by SSM and TAF. This makes researchers at the universities to get familiar with the problems being dealt by the industry. Universities are now doing research in this area. Finally, government provides various incentives and grant opportunities for R&D projects in the last decade. There are now hundreds of companies doing R&D and collaborating certain attractive incentives and grants are provided to the industry for their R&D projects. The R&D incentives even increase more when the R&D projects are carried out in the technopolises which are created after with universities in theses technopolises.

3.1 MODSIM Technology Platform

In 2008, MODSİMMER initiated a technology platform, called **MODSIM Platform** in which industry, university and government get together to discuss strategies, policies, regulations and standards on M&S. Another mission of MODSİM Platform is to create awareness about M&S technologies by training the relevant parties and by organizing seminars and workshops. MODSİMMER leads this platform which is coordinated and carried out within its premises. The financing of this platform is mostly provided by the key players of the local M&S industry. The industry members of the MODSİM Platform can be found at http://www.modsim.org.tr/platform. MODSİM Platform has a three year long project in which four main work packages exist:

1. Proposing M&S strategies and policies to the authorities after performing a SWOT analysis and market research
2. Studying M&S standards and technologies and proposing them to the relevant parties
3. Developing project ideas by considering local and international needs and cooperating with international partners
4. Creating awareness among all stakeholders of the M&S community including university students and disseminating the information collected in this project.

Finally, as a part of this initiative, MODSİM Platform started to publish an M&S portal (www.modsim.org.tr) in Turkish last year.

4.0 SUMMARY

The usage and the importance of M&S technologies increases not only in the world but also in Turkey in the last decade. In order to utilize this critical technology effectively and efficiently especially in military, Turkish Armed Forces and the Undersecretariat for Defence Industries followed a systemic approach to M&S by assigning roles to academia and industry at all stages of procurement process for M&S tools. The systemic approach includes the followings: forming an M&S master plan, establishing an R&D center on M&S, starting a series of M&S projects carried out by both industry and academia and creating a technology platform on M&S.

MODSİMMER which is at a critical location of Turkey M&S approach received a significant financial support of State Planning Organization (DPT) of Turkey in 2007 to enhance its infrastructure and extend its activities also for dual use. In the near future, as the planned M&S projects will continue to be developed, an update of M&S master plan is to be considered. M&S projects for non-military use are to be started by making use of the current know-how and experience.

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